DOE/GO-102001-1165
NREL/BK-710-29267
May 2001

5.7.4 Energy-Efficient Elevators

Elevators consume a significant fraction of the total energy used in tall buildings. In low-rise and mid-rise buildings, their energy use is less substantial, but opportunities for improving conventional practices are huge. In addition to reducing energy use, newly selected elevators should minimize other environmental concerns, such as the potential for leaking hydraulic fluid, maintenance requirements, and future replacement cost.

The electricity-consuming elements of elevators are the drive/machine, car illumination (some elevator codes require this to be on all the time), and the controller. Though the illumination in infrequently used elevators can equal the drive consumption, in 99% of cases the drive is the dominant consumer.

Opportunities

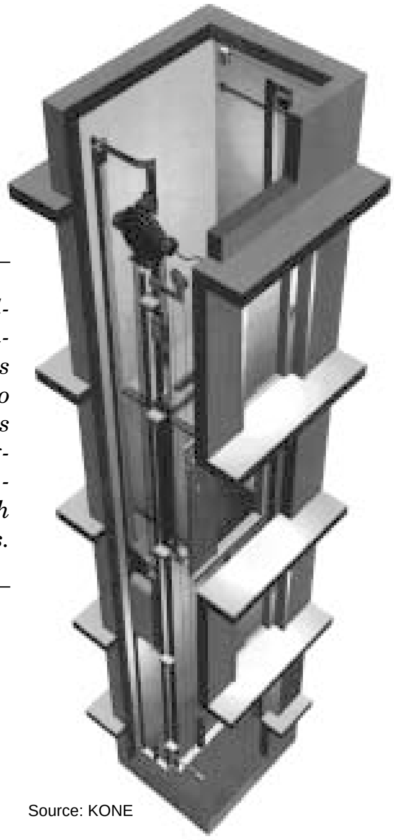
The greatest opportunity to select lost-cost, high-performance elevators is early in the design process for a new facility, because the type of elevator selected can significantly affect the space and structural requirements of the hoistway and ancillary spaces. Any time equipment needs replacing or significant maintenance, however, upgrading to more energy-efficient and environmentally friendly systems should be considered. Elevators in high-rise buildings use significant amounts of energy, so even marginal improvements in their efficiency can translate into significant savings. The most significant improvement opportunities exist in low-rise buildings because the hydraulic elevators typically installed in these facilities are the least efficient and the most problematic in terms of pollution from hydraulic fluid. Switching to a less toxic hydraulic fluid should be considered for buildings with hydraulic systems that are not candidates for replacement.

Technical Information

Good data on the fraction of a building's energy use represented by elevators is sparse, but a typical estimate is 4–10%. A recent survey of ten high-rise residential buildings by Canada Mortgage and Housing Corporation found that the elevators' share in overall energy use was 3–9%. As with lighting, all energy used by elevators is converted into heat, so excess energy use translates into increased cooling loads as well. Elevator shafts can also be significant sources of lost heat in cold climates, due to poor airtightness and the strong upward pressure of hot air, or the stack effect.

Elevator technology is a highly specialized field, with many factors affecting comfort, safety, energy efficiency, and maintenance requirements. In very general terms, elevators for low- and mid-rise buildings are typically either hydraulic or traction (gear-driven) systems, while high-rise buildings use variable voltage-variable frequency (VVVF) controlled gearless AC-motors replacing earlier DC technology. A more recent evolution is the availability of VVVF systems for low- and mid-

$ Hydraulic elevators tend to increase in cost roughly in proportion to the number of stops. More sophisticated elevators, on the other hand, are only incrementally more expensive with each added stop. Consequently, in low-rise applications, high-performance elevator systems tend to cost significantly more than hydraulics do. Other factors affecting the cost comparison include the reduced cost for electrical supply and connections when the elevator's maximum draw is reduced by two-thirds. Selecting a system that does not require a machine room also reduces the cost.


Source: KONE

In the EcoSystem elevator a thin, permanent magnet motor is mounted directly to the hoisting rail. This technology offers significant energy savings compared with conventional systems.

rise applications, which makes the energy efficiency and comfort of that technology available to buildings that are not so tall.

While the initial cost of hydraulic elevators makes them typically the least expensive for short runs, their inefficiency and the potential for groundwater contamination from leaking hydraulic fluid make them less desirable environmentally. Conventional hydraulic elevators require that a shaft be drilled in the ground that is equivalent in depth to the height of the lift. Modified systems use a telescoping shaft or a hydraulic lift with cables to avoid the complications of the long, in-ground shaft. In addition, less toxic, vegetable-based hydraulic fluid—although costly—is available to reduce the risk of ecological and health damage.

The latest VVVF technology with a permanent-magnet, synchronous motor also offers the possibility of saving space and construction costs because, up to certain elevator load/speed values, the small motor actually fits inside the hoistway. When mounted directly on the main car guiderails, this design avoids the need for a separate machine room and reduces the structural demand on the building because the guiderails support the load of the moving car. Initially introduced only for smaller applications, this guiderail-mounted motor technology is now expanding into longer runs and larger sizes, including freight elevators.

Any elevator system with significant traffic can also benefit from a control system that provides the most cars where they will be needed while reducing unnecessary travel. Some manufacturers now offer sophisticated computerized controls capable of optimizing energy consumption in addition to reducing response and travel time, including systems based on fuzzy logic that self-adjust based on travel patterns. Simpler controls can be programmed to cut off power to some cars during low-usage periods, reducing standby energy use. Finally, cab lighting can be a large factor, as these lights are usually on all the time. Higher-efficiency lamps often also have longer service lives, which reduces the labor cost associated with lamp replacement.

References

"New energy-efficient lift concept," from CADDET Energy Efficiency, a program of the International Energy Agency and the Organization for Economic Cooperation and Development; www.caddet-ee.org/techbroc/r314.htm.

"EcoSystem: A Better Elevator," *Environmental Building News*, Vol. 8, No. 7/8, p. 7, July/August 1999; BuildingGreen, Inc., Brattleboro, VT; (800) 861-0954. This review is posted on the BuildingGreen Web site: www.BuildingGreen.com.